AUTOMATIC PRODUCE-BAGGING MACHINE THAT USES FACTORY-ROLL POLYETHYLENE NET TUBING

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PREFACE

The work on equipment development described in this report was conducted by the Agricultural Research Service, US. Department of Agriculture, in cooperation with the Florida Agricultural Experiment Stations, Institute of Food and Agricultural Sciences of the University of Florida. It was initiated and mainly carried out under the general supervision of Joseph F. Herrick, Jr., now agricultural marketing specialist, Horticultural Crops Marketing Laboratory, Agricultural Marketing Research Institute, Northeast Region, Agricultural Research Service, U.S. Department of Agriculture. The concluding portion was under the general supervision of Dean F. Davis, area director, Florida-Antilles Area, Southern Region, Agricultural Research Service, U.S. Department of Agriculture. Ernest T. Smerdon, chairman, Agricultural Engineering Department, Institute of Food and Agricultural Sciences, University of Florida, acted jointly in general supervision during the entire period of work.

Grateful acknowledgment is made to American Machinery Co., Orlando, Fla., for supplying staples, air staplers, and a Pac-Rite count-fill unit. Deep appreciation is expressed to E. I. du Pont de Nemours & Co. for furnishing polyethylene net tubing (Vexar).

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By Earl K. Bowman and John C. Teele[1]

SUMMARY

An experimental model produce-bagging machine is described. The machine forms bags from factory-roll polyethylene net tubing, fills and closes them, and ejects them onto a conveyor in a continuous automatic cycle. Test bagging of oranges showed that the basic design concepts in the machine are sound. With refinements, equipment manufacturers can build commercial models based on it.

The machine has economic advantages over the semiautomatic equipment now widely used. First, being entirely automatic, the bagging operation requires less labor. Second, bag forming is incorporated into the automatic cycle, a feature not found on currently available automatic bagging machines. Thus the expense of manufactured bags is eliminated.

Costs based on 5-pound bags of oranges packed in master cartons show that a saving of $7,257 may be realized on an annual volume of 1 million bags (125,000 master cartons) with a commercial machine incorporating the features of the experimental model, compared to the prevailing semiautomatic method for filling and closing polyethylene net bags. On 31 million bags, the total for citrus fruit shipped in polyethylene net bags from Florida in the 1970–71 season, this would amount to a saving of better than $233,000. Commercial models of the machine should be usable for 8-pound bags as well as 5-pound and for grapefruit of bagging size as well as oranges.

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INTRODUCTION

Oranges and grapefruit have been packaged in bags at the shipping point for more than three decades in Florida. For about 20 years it was all done manually. Only fabric mesh bags were used before polyethylene film bags, which first appeared in Florida statistics for the 1958–59 season, were introduced (fig. 1). Polyethylene net bags (Vexar) first appeared in Florida statistics for the 1966–67 season *(2)*.[2]

[2] Italic numbers in parentheses refer to items in "Literature Cited" at the end of this report.

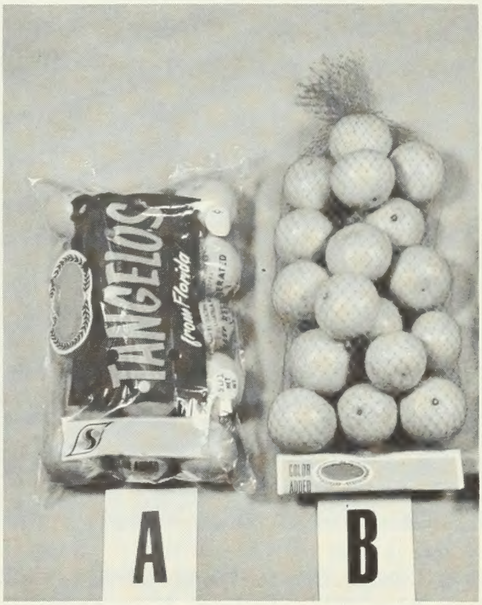


Figure 1.—Representative bags used in Florida citrus industry. *A*, Polyethylene film, heat-sealed, "pillow" type, more commonly gathered and stapled for top closing . *B*, Polyethylene net.

In Florida most citrus bagging in polyethylene film bags is done by semiautomatic machinery; some automatic machines are in use. In all semiautomatic bagging operations, purchased (premade) bags are used entirely. The representative semiautomatic equipment used in a large portion of the packinghouses counts the desired quantity of fruit into the bag upon actuation of a foot pedal or other control by the operator. The operator holds the bag in position to catch the fruit, then closes it by a tape or stapling device, and places it in a master carton (fig. 2). Similar semiautomatic equipment is used elsewhere for packaging such produce as apples, onions, and potatoes in polyethylene film bags. Generally, this equipment measures quantity by weight instead of count. Machine action or the operator pours the measured quantity from a pan or accumulating chamber into the bag after the machine feed has stopped at a preset weight. Bag closing practices are similar to those employed in semiautomatic citrus bagging operations. Semiautomatic machines suitable for polyethylene film bags are also generally usable for bagging fruit in polyethylene net bags.

Automatic polyethylene film bagging machines have been installed in several Florida packinghouses over approximately the past 3 years. Premade bags are used by all of them except for one make that uses specially prepared film, doubled, in a ribbon with perforations in heat-sealed strips between bags. The bagging machine heat-seals the top after filling except where twist-tie or Kwik-lok closing has been substituted. Bags separate along perforation lines in passing out of the machine onto the takeaway conveyor (fig. 3). Manual checking of bag weight is required in operating one make of these machines, a carrousel type (fig. 4).

No fully automatic machines are available for handling polyethylene net bags except one type, recently offered in the Florida citrus area, with an attachment for automatically handling net bags supplied on wickets. Thus far, the tooling of bagmakers has not provided for supplying polyethylene net bags in this way. Even if manufacturers were to supply these bags on wickets, the price of the bags might be higher than that for net bags supplied in the usual manner.

Polyethylene net bags are being used more and more for packaging produce. In Florida, for example, 6.8 percent of fresh fruit shipped was in net bags (31,061,651 bags) during the 1970–71 season—more than double the 3.1 percent (16,879,502 bags) shipped during the 1966–67 season, when net bags first appeared in Florida statistics. Although part of the in-

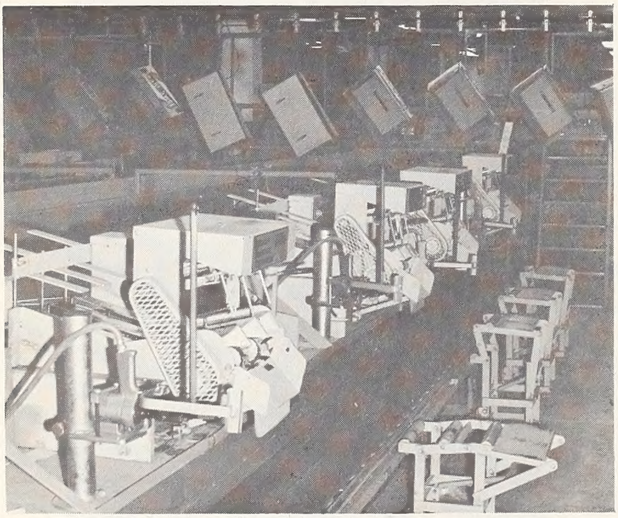


Figure 2.—Semiautomatic count-fill units, group of four, currently predominant in Florida citrus packinghouses. Air stapler with nearest unit is at left foreground; empty master cartons on monorail supply conveyor. Packing stands and filled-carton takeaway conveyor are also visible.

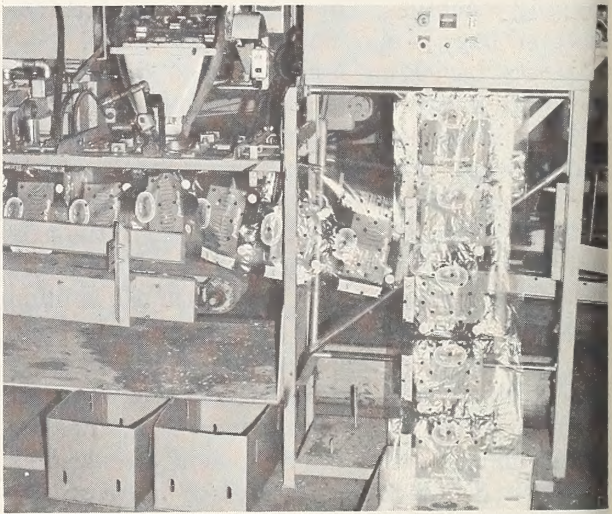


Figure 3.—Automatic bagging machine using polyethylene film in special ribbon form, perforated between bags. Special material input shown in foreground; count-fill unit and fruit guide are at upper center. Filled bags are like *A*, figure 1.

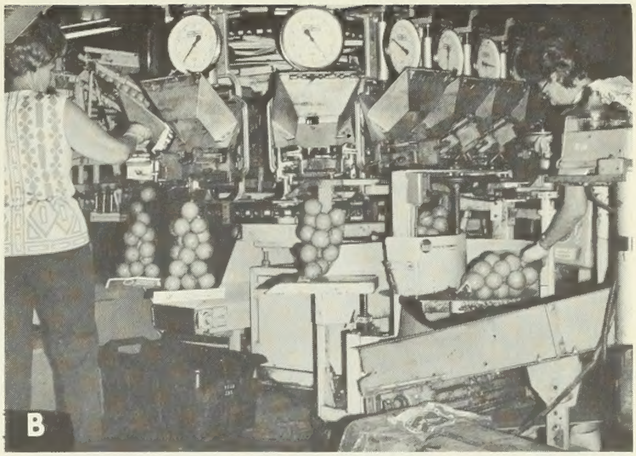


Figure 4.—Carrousel bagging machine. *(Top)* Workers hanging polyethylene net bags on filling heads. Device for automatic hanging of polyethylene film bags at left foreground, loaded with bags on wickets. *(Bottom)* Filled bag discharge. Worker at left is check-weighing and worker at right is attending the automatic staple-closing unit.

crease is attributable to discontinuance of fabric mesh bags for citrus by the Florida Citrus Commission (now the Department of Citrus) in 1967 *(1)*, polyethylene net bags have been favorably received in marketing channels because they improve package appearance and quality maintenance of produce. Simulated shipping and marketing tests with various kinds of citrus have shown that there is less spoilage of fruit in net bags than in film bags *(3, 4, 6)*. Further, the cooling response of citrus in net bags is better *(5, 8)*.

Manufactured polyethylene net bags cost about twice as much as film bags. Economic advantages would accrue to consumers and packers alike by having bag forming incorporated into an automatic cycle of bag filling and closing, as in the experimental machine.

Testing of the machine was confined to packing 5-pound bags of oranges because of their lead in shipments of Florida citrus fruit in polyethylene net bags. The machine is adaptable, however, to other bag sizes, produce, and applications.

DESIGN OF MACHINE

The bagging machine (fig. 5) is designed to form bags from factory rolls of polyethylene net tubing (fig. 6), fill the bags with produce, and close and eject them in a continuous automatic cycle. The machine consists of six main parts: (1) an opening and gripping mechanism,

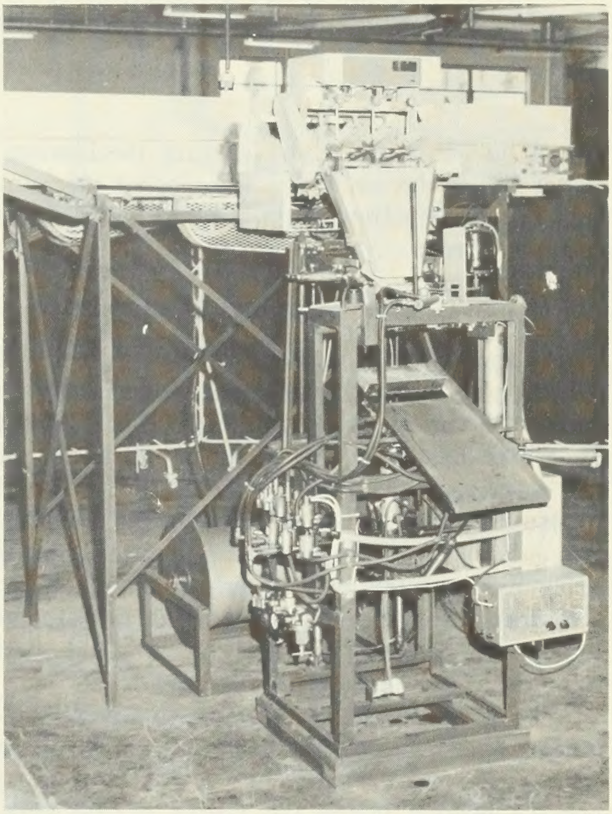


Figure 5.—Experimental model polyethylene net bagging machine. Fruit supply conveyor and commercial count-fill unit are in light tone at top. Supply roll of polyethylene net tubing is on reel on the floor at rear of machine. Triggering circuitry, direct-current power supply for photoelectric control of top closing, and variable transformer are in box on machine frame, lower right. The machine is 65 inches high.

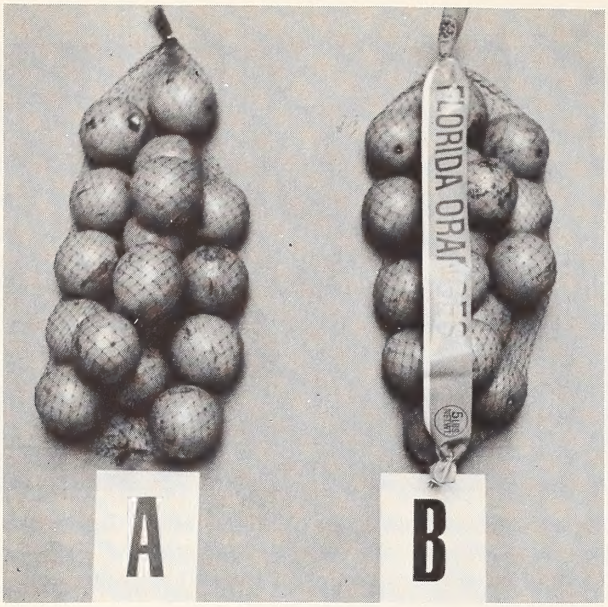


Figure 6.—*A*, Polyethylene net bag produced by experimental machine. *B*, Polyethylene film strip label attached manually for demonstration.

(2) a bottom-closing and cutting mechanism, (3) a filling device, (4) a top-closing mechanism, (5) an ejection chute, and (6) automatic action controls.

Opening and Gripping Mechanism

At the end of the downward movement of the gripping head, the four gripping fingers go inside the end of the net tubing (figs. 7*A* and 8), which has been opened by popup action of the spring-loaded top part of the internal spreader inside the net tubing (fig. 9*B*). Simultaneously, the spring-loaded spreader top is pushed downward by the gripping fingers to a latched position. The spreader is now ready to pop up when tripped by the solenoid-actuated trippers in the next cycle (fig. 9*A*).

The gripping fingers, actuated by air cylinders, open, stretch the end of the net tubing to a rectangular shape, and press it against nonslip inserts inside the frame of the gripping head (fig. 8). The gripping head then raises to its top position to provide the necessary length for the bag and to have the open top of the tubing in position under the chute of the count-fill device (fig. 7*B*). During the upward movement the spreader floating inside the tubing opens it from the flattened and wrinkled state in which it comes from the factory roll. The spreader floats just above the stationary spreader guide ring and seat (figs. 7*A*, 9, and 10) as the upward movement of the net tubing takes place. The weight of the spreader in the experimental machine is 3.25 pounds (fig. 9), and the upward movement of the gripping head is at a rate of approximately 54.7 feet per minute (21 inches in 0.032 minute).

Bottom-Closing and Cutting Mechanism

The basic component of the bottom-closing and cutting mechanism is a commercial air-operated stapler (model HR-S International Staple). The stapler is mounted on a swing action arm, which moves it into position for closing and cutting the tubing and then back to clear the vertical movement of the gripping head (figs. 10 and 11). Space limitations necessitated positioning the stapler with the magazine downward instead of in the normal upright position, and, lacking gravity feed, a spring was added to push the staples upward. An air cylinder provides power to swing the arm. A part was made for the stapler head with a larger V-shaped guide notch than that originally provided, and a knife was attached on the bottom surface (fig. 12). The knife is powered by a separate air cylinder. A microswitch, actuated by the gathering arm that moves with the knife, triggers the stapler when the gathering action is completed and just ahead of the cutting action. There was a tendency for the material to slip upward and out of the stapler before completion of stapling if cutting was completed first.

Filling Device

A commercially made count-fill device (Pac-Rite patented count bagger) was used to fill the bags. The count type, which measures a preset number of fruit into the bag, is generally familiar in the Florida citrus industry, but various commercial filling units could be used. An interconnection must provide a pulse to start the filling action when the gripping head is in the top position holding the open bag and the bottom closing has been completed. When filling is complete, a pulse is needed from the filling machine to continue the cycle.

(Continued on p. 10)

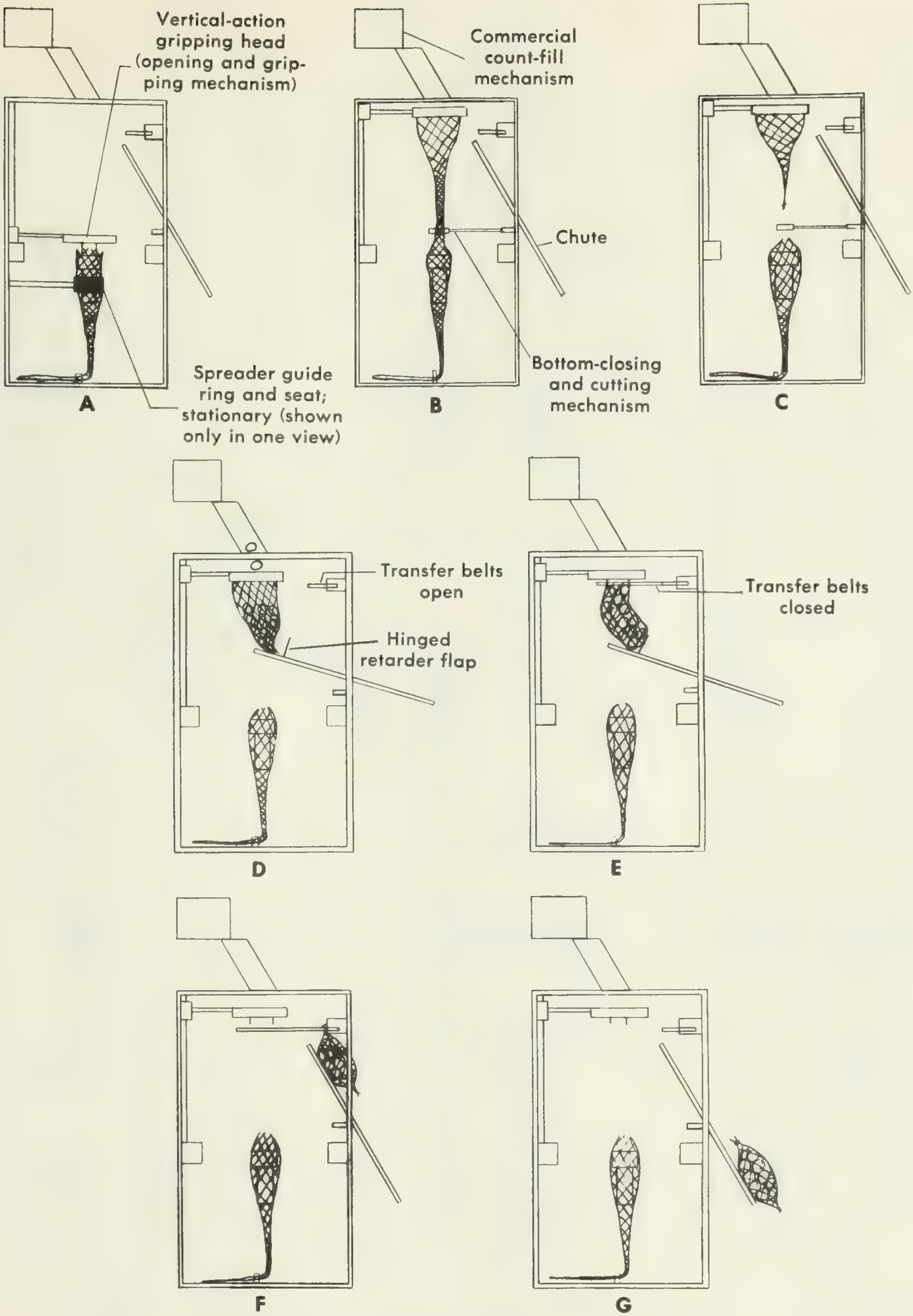


Figure 7.—Machine action sequence.

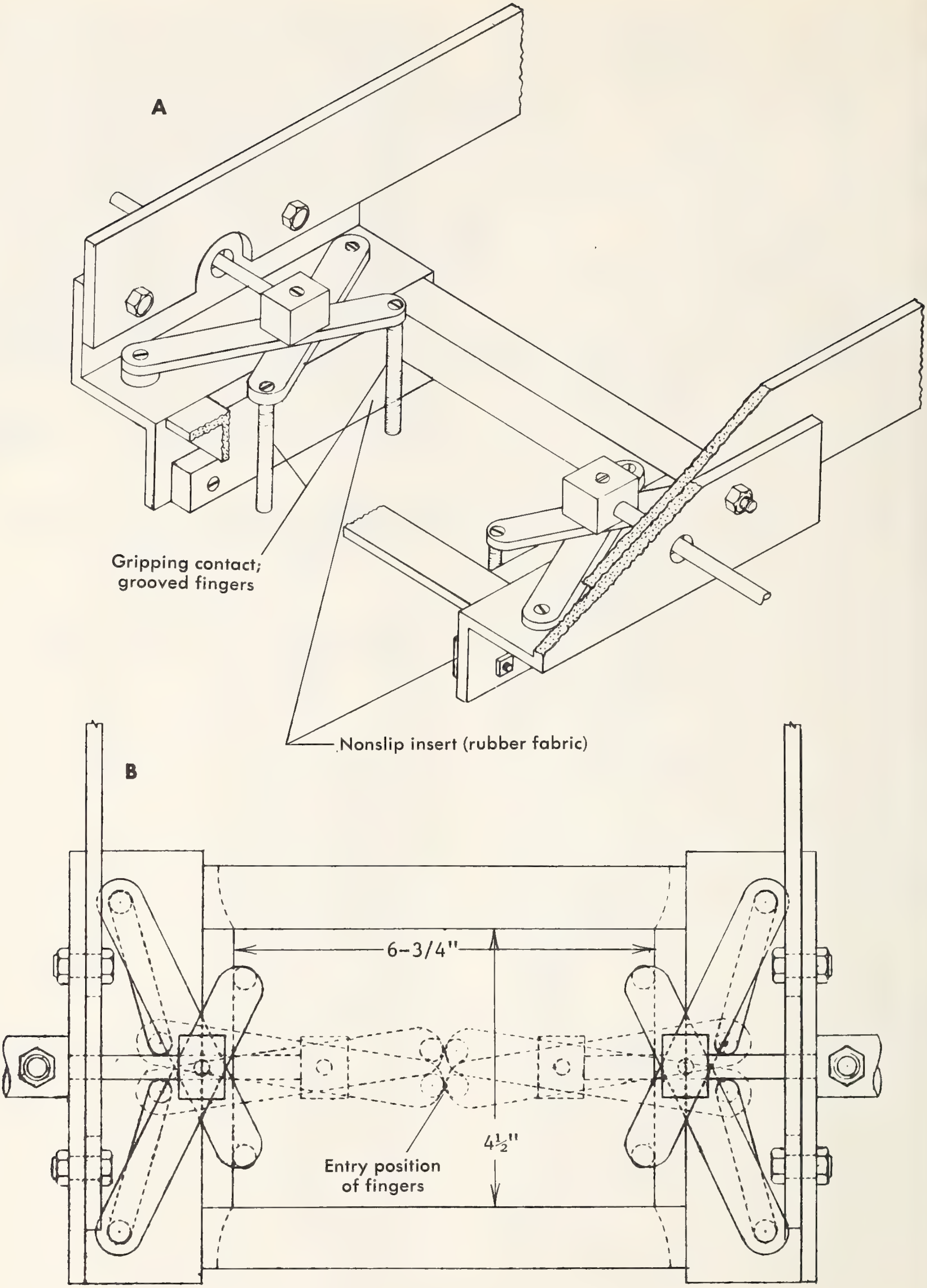


Figure 8.—Opening and gripping mechanism. *A*, Pictorial view. *B*, Top view.

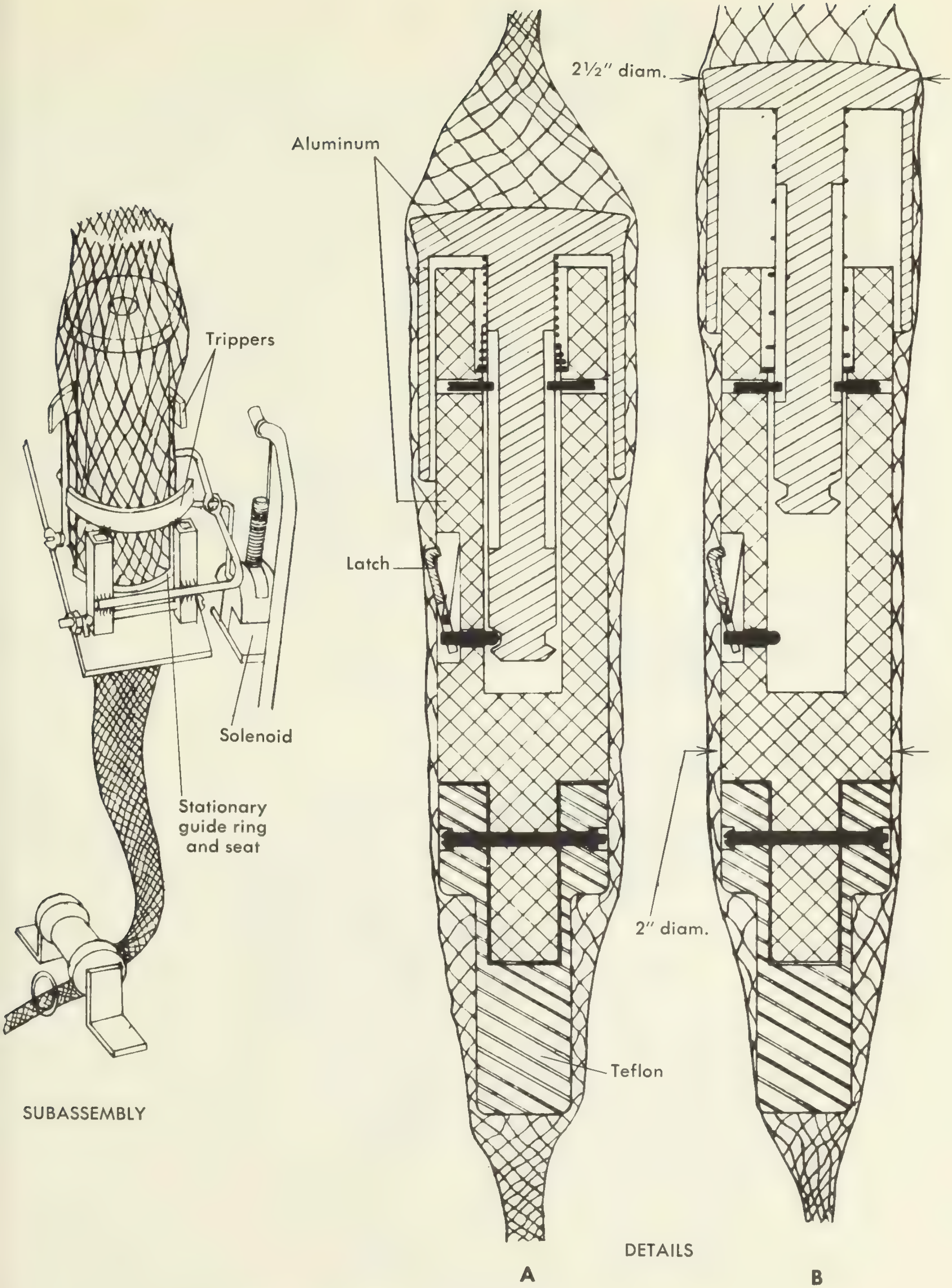
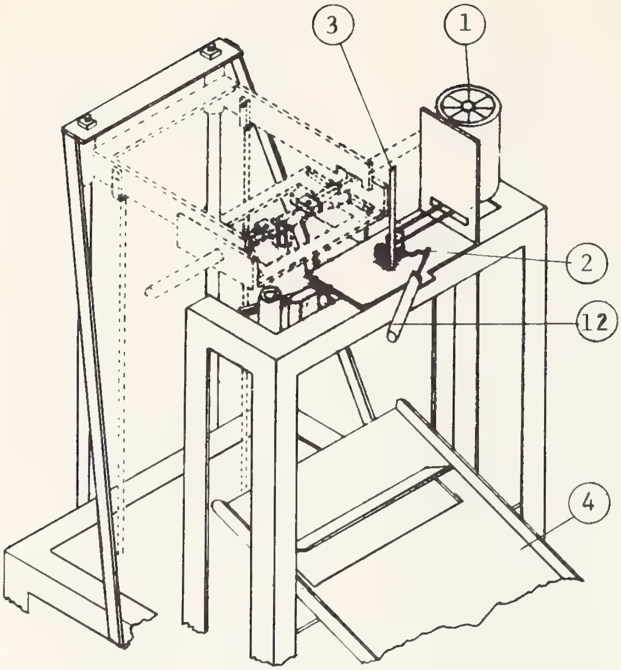


Figure 9.—Internal spreader, details and subassembly.



1. Electric motor, chain drive to transfer belts
2. Mechanism to swing transfer belt arms open and closed
3. Magazine of top stapler; top-closing mechanism not visible
4. Chute with retarder flap
5. Guide ring and seat for internal stock spreader
6. Internal stock spreader
7. Trippers for spreader
8. Opening and gripping mechanism
9. Guide rods for vertical action of gripping head
10. Bottom stapler; swing-action mounting
11. Specially made V-notch guide plate; gathering arm and stapler microswitch on top; knife underneath
12. Air cylinders

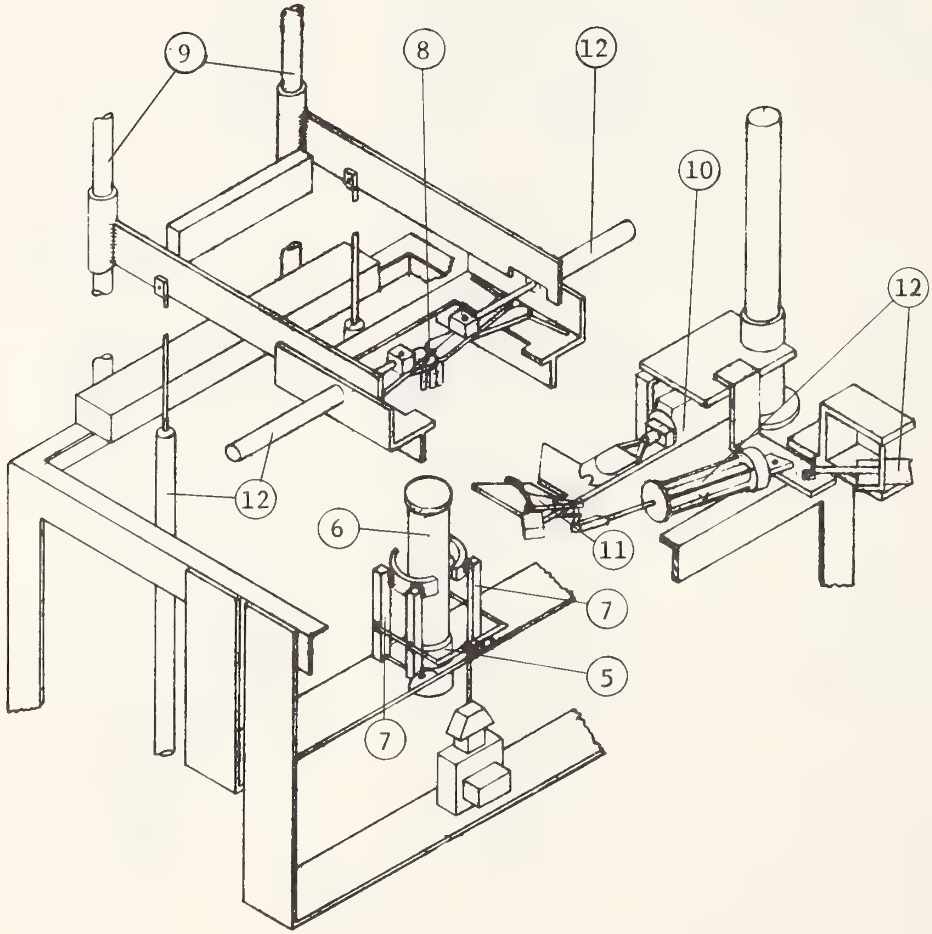


Figure 10.—Top and bottom parts of machine. Bottom shown in partially exploded view.

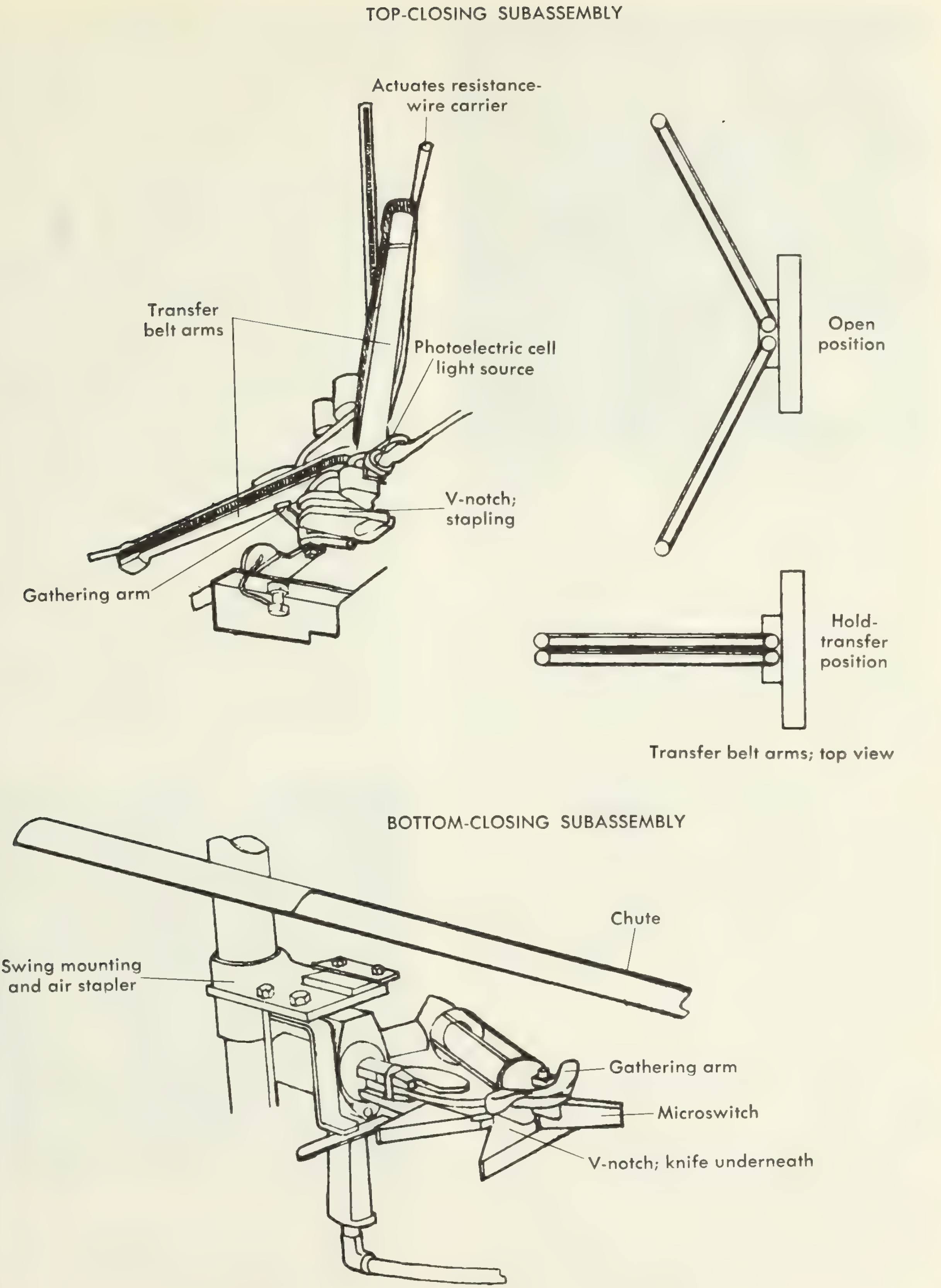


Figure 11.—Top-closing and bottom-closing subassemblies.

Figure 12.—Bottom-closing stapler head. (1) Gathering arm and microswitch on top of the specially made V-shaped guide notch. (2) Knife on bottom surface.

Top-Closing Mechanism

Transferring the filled bag from the gripping head into a closing mechanism, obtaining consistently satisfactory closure, and discharging the filled bag from the machine were the most complex series of actions to incorporate into a working mechanism. A commercially made air stapler identical to the one used in the bottom-closing mechanism, but mounted in a fixed position, is used as a basic component in the top-closing mechanism. In addition, the mechanism consists of transfer belts, a gathering arm to push the material into the stapler notch, a photoelectric cell control, and resistance wires (figs. 7, 11, and 13).

When the preset number of fruit are in the bag, a pulse from the count-fill device causes the transfer belts to swing together, pressing the net material between them and moving the two resistance wires into contact with the material at each side. They then transfer the bag top from the gripping head into the stapler (fig. 7*D–F*). The gathering arm is triggered by the photoelectric cell responding to the passing of the bag. The movement of the gathering arm actuates the microswitch that operates the stapler (fig. 13).

Although the gripping fingers are released when movement of the transfer belts starts, the resistance wires melt the net material just below the gripping fingers, thereby preventing the bag from hanging on the fingers and hampering action of the transfer belts. Transfer belts of more rugged construction and more powerful gripping action might pull free material hanging on the gripping fingers after they are released, thereby eliminating the need for the hot wires.

Some difficulties in the top-closing mechanism were the result of improvising with equipment not especially designed for this application. One of the most persistent problems was lack of consistent gathering of the net into the small space required to have all the material encircled in a staple. Timing was critical. The net had a tendency to slide down if stapling did not take place within an instant after the material had been moved into the stapler by the transfer belts. After attempting to trigger the action of the gathering arm by a microswitch arranged for actuation by pressure of the material as it was gathered into the stapler notch, the photoelectric cell and triggering circuitry were installed to provide better control. A commercially made machine would not necessarily require a photoelectric control for the top-closing mechanism. Redesign of the transfer belts and gathering arm and more tolerance in gathering all the bag top

Figure 13.—Top-closing mechanism *(right)* and opening and gripping mechanism in raised position *(left)*, looking upward. (1) Resistance wires. (2) Gathering arm. (3) Special V-notch attachment on stapler with slot to accommodate gathering arm movement. (4) Light source. (5) Photoelectric cell.

for catching in the staple (or whatever closing means may be used) could allow the use of a microswitch, a simpler and less expensive control than a photoelectric cell.

Ejection Chute

A chute tilts progressively as the transfer belts move the bag toward the stapling mechanism, reaching the fully tilted position (57°) as stapling is completed. The bag drops clear of the closing mechanism and slides down the chute and onto a conveyor belt. The chute returns to a near-horizontal position (17°) after the gripping head has traveled to the top position with the bag held open ready for filling and after the bottom cutting and closing action has been completed. The inside end of the fully tilted chute must clear the vertical travel of the gripping head. As filling starts, the fruit flowing into the bag causes the bottom of the bag to flip onto the inside end of the chute, which provides support as filling progresses (figs. 7 and 10).

A hinged retarder flap near the inside end of the chute prevents movement of the bag bottom when fruit falls into the bag and thus prevents undesirable elongation and lateral construction of the bag. The retarder flap is operated by a separate, small air cylinder, and as the chute moves toward the inclined position for discharging the filled bag, the flap drops down to make a smooth surface (figs. 7*D–F* and 10).

Automatic Action Controls

Except for the previously discussed photoelectric and microswitch controls, timing and sequencing of the actions in the cycle are accomplished by a high-torque, synchronous motor-driven, single-cycle, multicam timer. The single-cycle, rather than continuous, cam timer provides a relatively simple way to connect the machine with the count-fill unit to obtain automatic operation. A pulse from the count-fill unit starts the timer when the preset number of fruit has been delivered into the bag. The timer then runs through the cycle, coming to a stop with the bagging machine in readiness for filling the next bag. The filling operation starts immediately by a pulse from the timer to the count-fill unit. Thus, continuous automatic action is obtained (fig. 14).

The resistance wires in the top-closing mechanism are hot as long as the master switch of the machine is on. A variable transformer in the circuit permits temperature regulation.

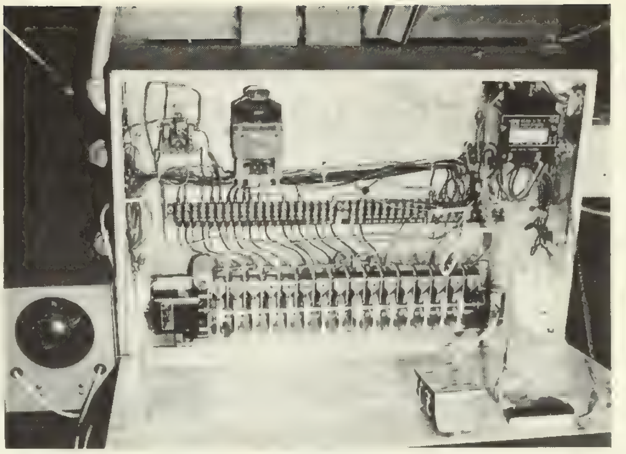


Figure 14.—Inside main control box. Cam timer at bottom. Adjusting knob visible at left for variable transformer (control of resistance wire temperature) mounted in triggering circuit control box.

The actions of the machine are predominantly powered by air cylinders. Solenoid-operated air valves effect the necessary airflow as their respective electrical circuits are energized and denergized by the cam timer. Table 1 gives the control arrangements for all actions performed by the machine.

SUGGESTED DESIGN MODIFICATIONS

Adjustment in Bag Length

The experimental machine cannot be adjusted to vary the length of the bag. In a commercial machine, the length of stroke of the mechanism for raising and lowering the gripping head should be adjustable to vary bag size (from 5- to 8-pound, for example).

Settling Fruit During Filling

In test operations fruit stacked up too high in some bags and interfered with the transfer belts and closing mechanism. A device to vibrate the chute during filling and thus settle fruit in the bag might overcome the problem. A small-amplitude, powered vertical movement of the chute fulcrum bar end supports, which would be made and mounted to permit sliding action in a short-distance range, might be used.

TABLE 1.—Machine actions and controls

Machine action	Source of control signal	Actuation means
Gripping fingers open and grip net tubing; release tubing and close.	Cam timer	4-way solenoid air valve; 2 double-action air cylinders.
Raise and lower gripping head	do	4-way solenoid air valve; 2 double-action air cylinders.
Swing bottom-closing mechanism into action and return	do	2 solenoid air valves per cylinder; double-action air cylinder.
Staple and cut bottom	Cam timer and microswitch.	Solenoid air valves; 1 for single-action air cylinder on gathering arm and knife; 1 for air stapler, which operates on signal from microswitch actuated from gathering arm.
Raise and lower chute	Cam timer	2 solenoid air valves per cylinder; double-action air cylinder.
Raise and lower retarder flap	do	Double-action air cylinder connected to chute air lines.
Fill bag	do	Count-fill device motor drive, started by pulse from cam timer, stopped by counter and control circuitry of count-fill device.
Top closing:		
Transfer belts swing action	do	2 solenoid air valves per cylinder; double-action air cylinder.
Resistance wires sever net	Cam timer (through transfer belts).	Transfer belts move hot wires to action position; spring return to clear position when transfer belts swing open.
Transfer belts operate	Cam timer	Electric-motor drive.
Gathering arm	Photoelectric cell[1]	Solenoid air valve; single-action air cylinder.
Stapling	Microswitch	Microswitch actuated by gathering arm; solenoid air valve for air stapler.
Tripping popup of internal spreader	Cam timer	Solenoid with mechanical linkage for actuating trippers to strike spreader-latch lever.

[1] Includes Schmidt triggering circuit.

Compensating for Twist in Factory-Roll Tubing

The internal stock spreader occasionally needed rotating about its vertical axis because of the cumulative effect of twist in the polyethylene net tubing as it came from the factory roll. Not enough tubing was used to provide reliable information concerning the magnitude of this effect or whether it would be found in every roll. When rotation of the spreader was needed, it was done manually. A mechanism might be provided to rotate the internal spreader by action upon the spreader guide ring and seat, which would have to be mounted to permit turning rather than rigidly attached as in the experimental machine. The mechanism could act intermittently and automatically.

Applying Label

The means to apply labels automatically will depend upon the type of bag-closing device incorporated into a commercial machine. Given a staple closure, preprinted polyethylene film strip in rolls could be carried through the bagging machine with the net tubing and stapled at each end of the bag as part of the closure (fig. 6). With the proper automatic closing unit, preprinted Kwik-loks could also be used.

Opening and Gripping Mechanism

To reduce the 65-inch height of the machine, the gripping head could be made stationary; the guide ring and internal stock spreader would be raised and lowered instead. Popup action of the spreader top would open the end of the tubing, as in the present mechanism, with the tubing moving up and around the gripping fingers, instead of the fingers moving down and into the top of the tubing. With the material opened and held by the gripping fingers, the guide ring and internal spreader would travel downward.

A mechanical drive to raise and lower the gripping head might replace the air cylinders used in the experimental machine. Cams might be incorporated in the drive to provide sequential timing for the different actions in the cycle. The separate motor-driven cam timer used in the experimental machine would then be unnecessary.

Top-Closing Mechanism

If a staple closing mechanism is used for the top of the bag, transfer belts should have effective gripping action on the bag top for an appreciable distance beyond the end of the gathering notch. This is important in respect to catching all of the material within the staple consistently, in addition to eliminating undesirable downward movement of the bag before the stapling action takes place. These were significant problems in the experimental machine.

Simplifying the control for triggering the top stapler by eliminating photoelectric components should be further considered. There appears to be a good possibility for sensing by mechanical action, employing a microswitch arrangement, the point at which the material has been fully gathered and pressed into position for the stapling or other action—with adequate clearance in the notch for the material.

ECONOMIC ASPECTS OF AUTOMATIC BAGGING MACHINE

To compare the economics of the widely used semiautomatic count-fill equipment and the automatic bagging machine, the annual cost of bagging 125,000 master cartons of oranges in 5-pound polyethylene net bags by each method was determined (tables 2–6). This output, representative of medium-size Florida citrus packinghouses, is based on four semiautomatic filling and closing stations (units) and two automatic bagging machines.

TABLE 2.—Cost of bagging oranges in polyethylene net bags and packing in master cartons by semiautomatic and automatic methods

[125,000 master cartons of 5-pound bags per year]

Cost item	Semiautomatic method	Automatic method	Difference (saving)
Equipment ownership and operation[1]	$3,046.41	$9,804.31	
Labor[2]	7,095.37	4,946.98	
Bags[3]	27,500.00	[4]14,383.32	
Staples[3]	980,00	1,960.00	
Total	38,621.78	[4]31,094.61	$7,527.17

[1] See tables 3 and 4 for breakdown of ownership and operating costs.

[2] See table 5 for breakdown of labor costs.

[3] See table 6 for breakdown of bag and staple costs.

[4] Includes polyethylene film label strip.

The production rate of 37 master cartons per man-hour or per unit (filling bags, closing, and master-cartoning performed by operator at each station) for the semiautomatic method ties in with the rate for size 252 oranges[3] given in an earlier report (7)—39.28 master cartons per productive man-hour or 35.71 per total man-hour of the crew which, in the crew organization used, included a small amount of enforced "wait for bags" by the bag closer and master carton packers.

For the proposed automatic form, fill, and close machine, in a commercial production model, 60 master cartons per machine-hour (8 bags per minute) was judged reasonable for comparative cost relationships. The experimental model operated at 5 cycles per minute (1 bag per

[3] Before change to size designation 125 based upon 4/5-bushel carton.

cycle), which is 37.5 master cartons per machine-hour. None of the research effort was focused on increasing the speed.

A saving of $7,527 per year can be realized with the automatic machine (table 2). This amounts to $60.22 per 1,000 master cartons, or 19.5 percent of the total annual cost of the semiautomatic method. On 31 million bags, the total for citrus fruit shipped in polyethylene net bags from Florida in the 1970–71 season, this would amount to a saving of better than $233,000. Although it costs more to own and operate and requires twice as many staples, the automatic machine saves on the costs of labor and bags. Similar savings could be expected for other produce suitable for machine bagging.

TABLE 3.—Annual ownership costs for equipment[1]

Equipment	Initial cost per unit	Expected life (years)	Depreciation	Interest[2] (7%)	Insurance and taxes (4%)	Total
Return-flow belt, 18″×20′ and 12″×16′	$1,662	10	$166.20	$63.99	$66.48	$296.67
Semiautomatic count bagger	1,900	10	190.00	73.15	76.00	339.15
Air stapler	250	10	25.00	9.62	10.00	44.62
Packing stands, folding	38	15	2.53	1.42	1.52	5.47
Container takeaway conveyor, 25′	1,550	15	103.33	57.87	62.00	223.20
Automatic net bagging machine with count-fill device	16,000	10	1,600.00	616.00	640.00	2,856.00
Closed bag conveyor, 25′	1,156	15	77.07	43.16	46.24	166.47
Skate-wheel conveyor, 3′	17	10	1.70	.65	.68	3.03
Carton chute, 30′	188	15	12.53	7.02	7.52	27.07

[1] Costs derived by increasing the cost of items (excluding semiautomatic count baggers and air staplers) given in an earlier report (*7*) by 25 percent to compensate for rising prices over approximately 10 years; ratio of increase based upon ratio of index for 1971 to index for 1960, machinery and equipment, wholesale prices, Survey of Current Business, by U. S. Department of Commerce. Vendor prices in 1972 were used for the excluded items.

[2] Computed on the average of the values at the beginning of the first and last years of estimated life.

TABLE 4.—Equipment ownership and operating costs for semiautomatic and automatic bagging methods

[125,000 master cartons of oranges in 5-pound bags per year]

Equipment	Ownership cost	Operating cost: Power[1]	Operating cost: Maintenance[2]	Operating cost: Total	Total cost per unit	No. units	Total
SEMIAUTOMATIC COUNT-FILL METHOD							
Return-flow belt, 18″×20′ and 12″×16′	$296.67	$44.41	$43.94	$88.35	$385.02	1	$385.02
Semiautomatic count bagger	339.15	6.34	146.10	152.44	491.59	4	1,966.36
Air stapler	44.62	[3]5.00	4.22	9.22	53.84	4	215.36
Packing stand, folding	5.47	....	4.50	4.50	9.97	4	39.88
Container takeaway conveyor, 25′	223.20	70.50	117.22	187.72	410.92	1	410.92
Carton chute, 30′	27.07	....	1.80	1.80	28.87	1	28.87
Total							3,046.41

AUTOMATIC FORM, FILL, AND CLOSE METHOD							
Return-flow belt, 18" × 20' and 12" × 16'	$296.67	$54.62	$54.18	$108.80	$405.47	1	$405.47
Automatic net bagging machine with count-fill device	2,856.00	7.80 [3] 35.00	1,667.20	1,710.00	4,566.00	2	9,132.00
Closed bag conveyor, 25'	166.47	31.21	36.16	67.37	233.84	1	233.84
Skate-wheel conveyor, 3'	3.03	....	.71	.71	3.74	1	3.74
Carton chute, 30'	27.07	....	2.19	2.19	29.26	1	29.26
Total							9,804.31

[1] Based on $0.03 per kilowatt-hour and ratio of 1972 hours of annual use to hours annual use in reference *7* except for compressed air, which is based on estimate.

[2] Based on percentage of initial cost per 100 hours of operation given in reference *7* except for automatic machine, for which relationship was estimated.

[3] Compressed air; estimated.

TABLE 5.—Labor requirements for bagging oranges by semiautomatic and automatic methods

[125,000 master cartons of 5-pound bags per year]

Crew-equipment arrangement	Avg. prod. rate per man-hour (master cartons)	Prod. man-hours per 100 master cartons	Total prod. (man-hours)	Elapsed hours	Hourly wage[1]	Total labor cost
SEMIAUTOMATIC COUNT-FILL METHOD						
1 worker per station, 4 stations	37	2.703	3,378.75	844.69	$2.10	$7,095.37
AUTOMATIC FORM, FILL, AND CLOSE METHOD						
1 attendant per 2 machines	120	0.833	1,041.25	1,041.25	$2.65	$2,759.31
1 worker for master cartoning	120	[2].626 [3].207	[2]782.50 [3]258.75	1,041.25	2.10	2,187.67
Total for automatic						4,946.98

[1] Based on 1972 rates.

[2] Based on 6.26 man-hours per 1,000 master cartons of 5-pound bags from earlier work (*7*).

[3] Wait for bags from form, fill, and close machines.

TABLE 6.—Cost of bags and staples for oranges packed by semiautomatic and automatic methods

[125,000 master cartons of 5-pound bags per year]

Item	Amount (millions)	Cost per 1,000	Total cost
SEMIAUTOMATIC COUNT-FILL METHOD			
Purchased bags	1	$27.50	$27,500.00
Staples	1	.98	980.00
Total			28,480.00
AUTOMATIC FORM, FILL, AND CLOSE METHOD			
Net tubing in roll	(1)	[2]$5.20	$9,533.32
Polyethylene label strip, 1½", 22" pieces[3]	1	4.85	4,850.00
Staples	2	.98	1,960.00
Total			16,343.32

[1] 1,833,330 ft. (22" per bag).

[2] Cost per 1,000 feet of net tubing.

[3] Price furnished by E. I. du Pont de Nemours & Co. includes printing 1 color on white.

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